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Risø energy report 9 : Non-fossil energy technologies in 2050 and beyond: Conclusions and recommendations

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Conclusions and recommendations

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The 2^0 target

To keep the global mean temperature rise below 2^0C we need to reach global stabilisation at 450 ppm CO_2eq

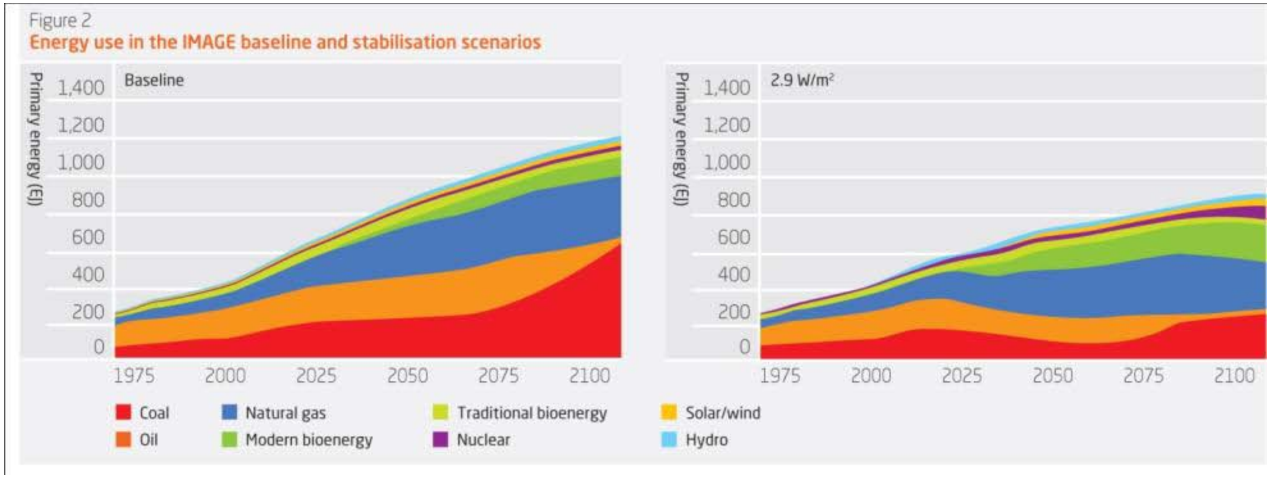
That means that global greenhouse gas (GHG) emissions must be halved by 2050 and in fact reduced even more in the OECD countries, maybe 80 %

Global energy scene 2050

The IMAGE baseline scenario (left) makes similar predictions to other scenarios in this report:

Fossil fuels will contribute about 80% of our primary energy in 2050

The 2.9 W/m2 stabilisation scenario (right) predicts a decrease in energy consumption of about 30% in 2050



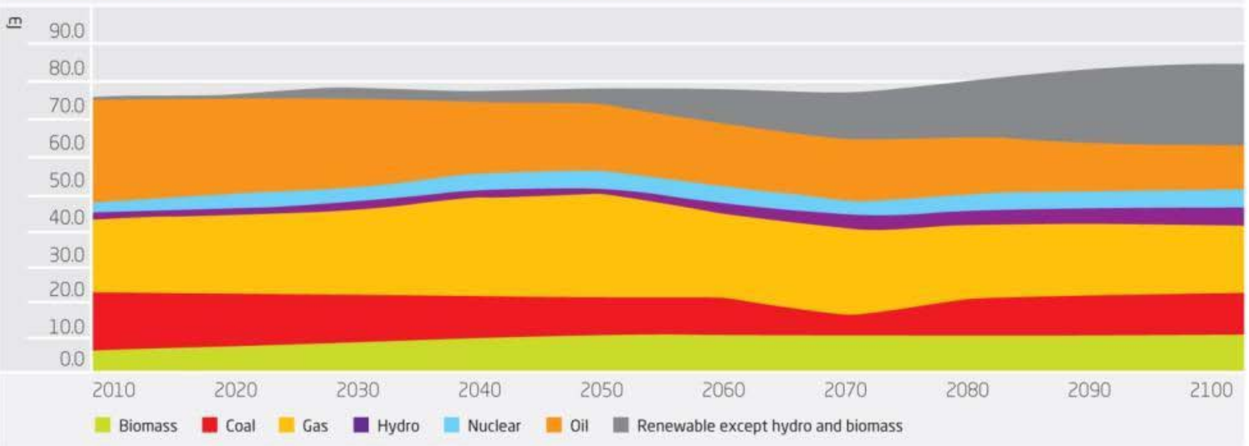
Renewable energy contributes about 30% of primary energy consumption in 2050 and also in 2100, and bioenergy is very dominant

Energy scenarios for Europe

The EU27+3 nations can manage stabilisation at 550 ppm CO_2eq if by 2050 they can reduce their GHG emissions by 40%

Even though focus is on the period up to 2050, the model is run until 2100 to make sure that GHG concentrations do not start to rise again after this time

Figure 6
Total primary energy consumption (including mining) in the EU27+3 countries in the 550 ppm CO_2eq stabilisation scenario.

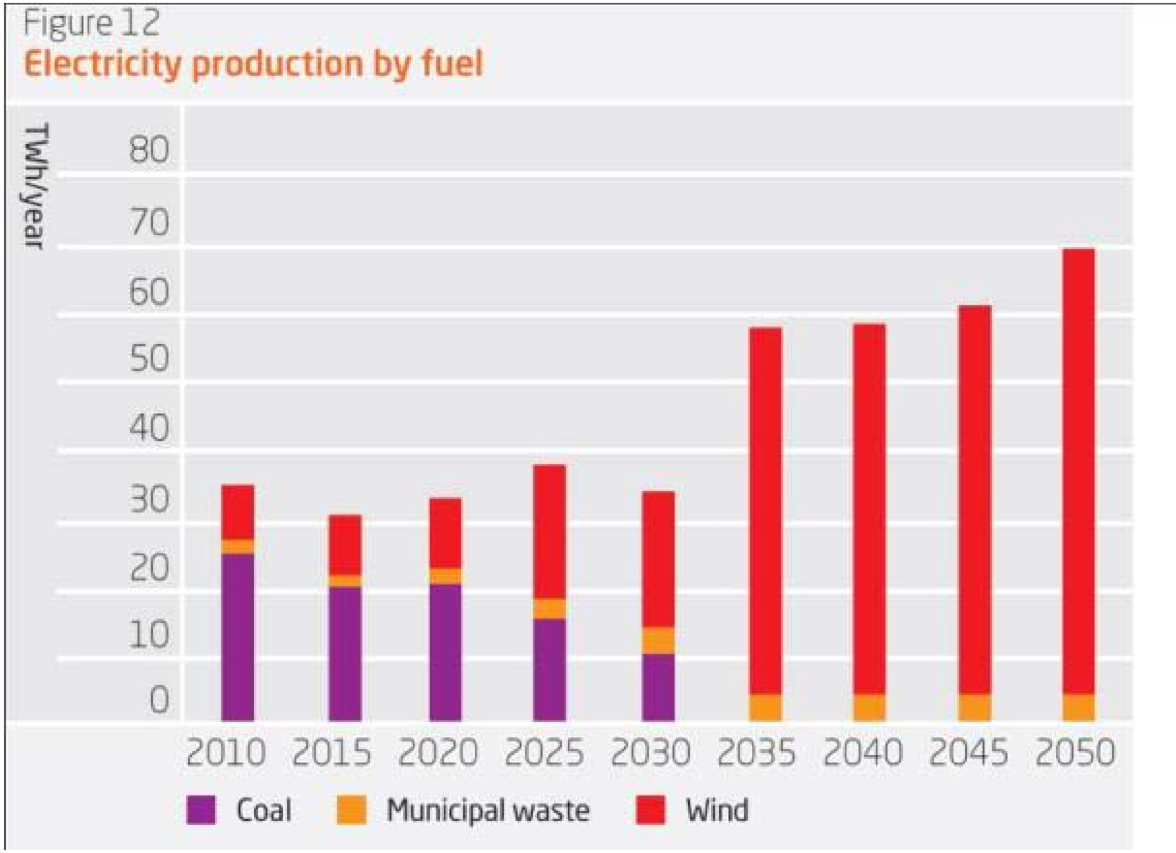


It will be difficult for the European countries to meet these targets as mitigation options from the energy sector alone do not seem to be sufficient

Energy scenarios for Denmark

Denmark has good chance of meeting the mitigation goals and of being able to phase out fossil fuels before 2040

Removing fossil fuels from the transport sector will probably take another 10 years

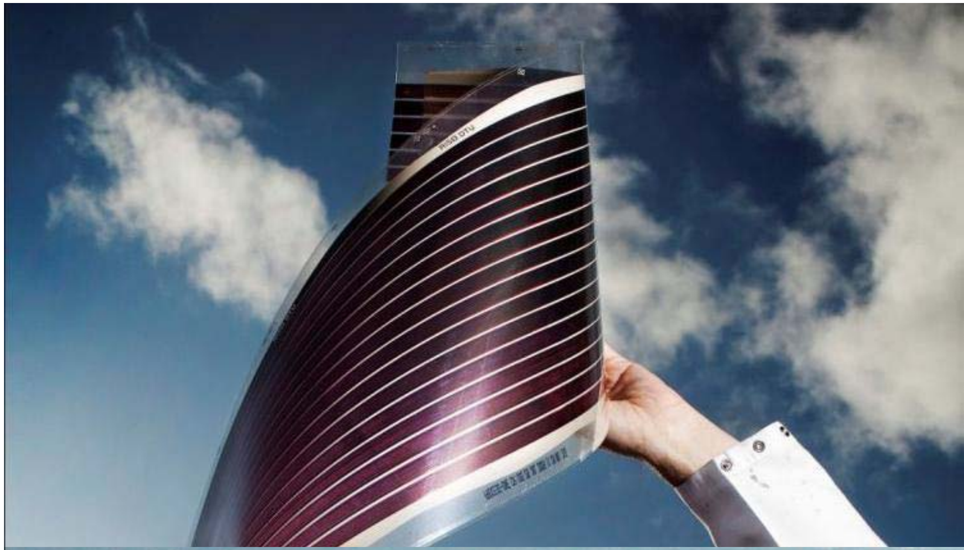


Solar

Solar energy can be used for production of heat and electricity all over the world

PV is by nature a distributed generation technology, whereas CSP is a centralised technology

By 2050 PV and CSP technologies will each produce 11% of the world's electricity.



Wind

Wind energy capacity has doubled every three years

Expected to generate more than 331 TWh in 2010, covering 1.6% of global electricity consumption

Has the potential to play a major role in tomorrow's energy supply, covering 30-50% of our electricity consumption

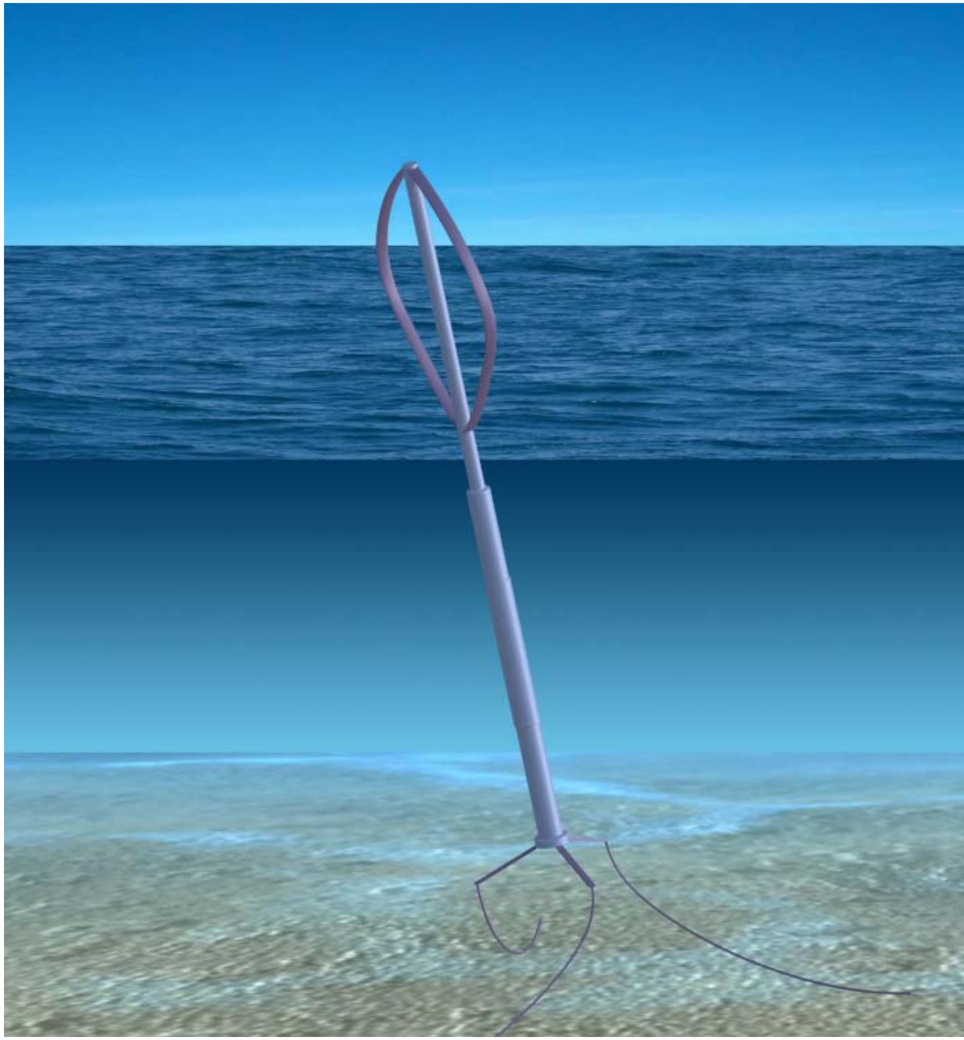
Costs is coming down

Figure 18
Using experience curves to forecast wind energy economics up to 2015. The costs shown are for an average 2 MW turbine with a present-day production cost of euro ¢6.1/kWh in a medium wind regime. From [3]

Emerging wind energy technologies

The coming decade may see new technological advances and further scale-up

With increased focus on offshore deployment combined with the radically different conditions compared to onshore, it is likely that completely new concepts will emerge, such as the vertical-axis turbine currently being developed at Risø DTU



Hydro

Hydropower is a mature technology

Wave energy is an interesting partnership with wind energy

Globally, the potential for wave power is at least 10% of total electricity consumption

A goal for Danish wave power by 2050 could be around 5% of electricity consumption

Biomass

To day 10% of the world's energy consumption. In 2050 up to 200-500 EJ/yr ~ up to half of the world's energy needs in 2050

A large proportion will be wood for direct burning in less developed areas of the world

An easily storable form of energy

Can be used in CHP systems

A source of liquid fuels for transport

A limited resource, and increases in biomass production should not compete with the food supply

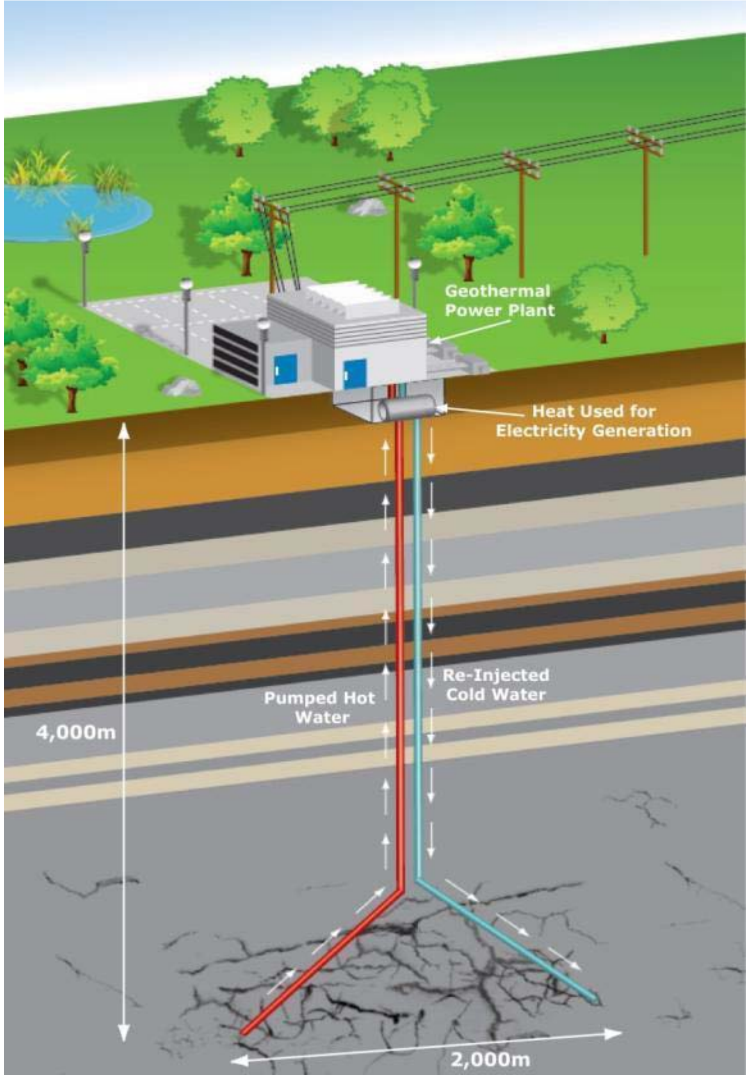
Geothermal

At least 24 countries produce electricity from geothermal energy, while 76 countries use geothermal energy directly for heating and cooling

Global production is 0.2 EJ, with 10 GW of installed baseload electricity production capacity

Potential in 2050 is approximately 200 EJ/yr, of which 65 EJ/yr from electricity production

In Denmark, the potential is substantial and could cover a large part of the demand for future district heating



Energy storage

Focused on electricity

Mobile storage technologies for vehicles are needed

Storing energy as hydrocarbons synthesised from carbon dioxide extracted from the atmosphere may become viable

There is considerable technical and economic potential for heat storage

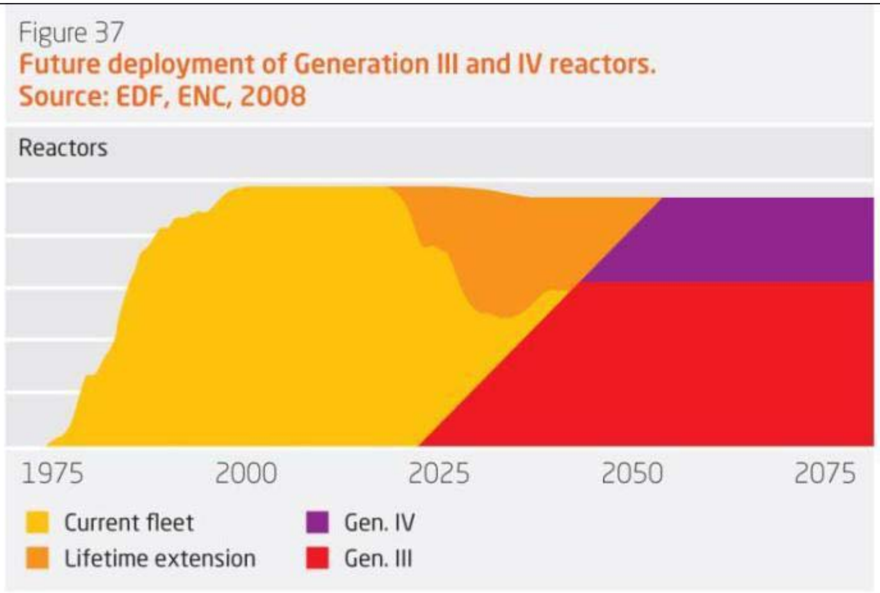
Important for a sustainable energy system

High costs

Nuclear fission

Nuclear fission is a proven technology and in total, nuclear provides 14% of the world's electricity consumption to day

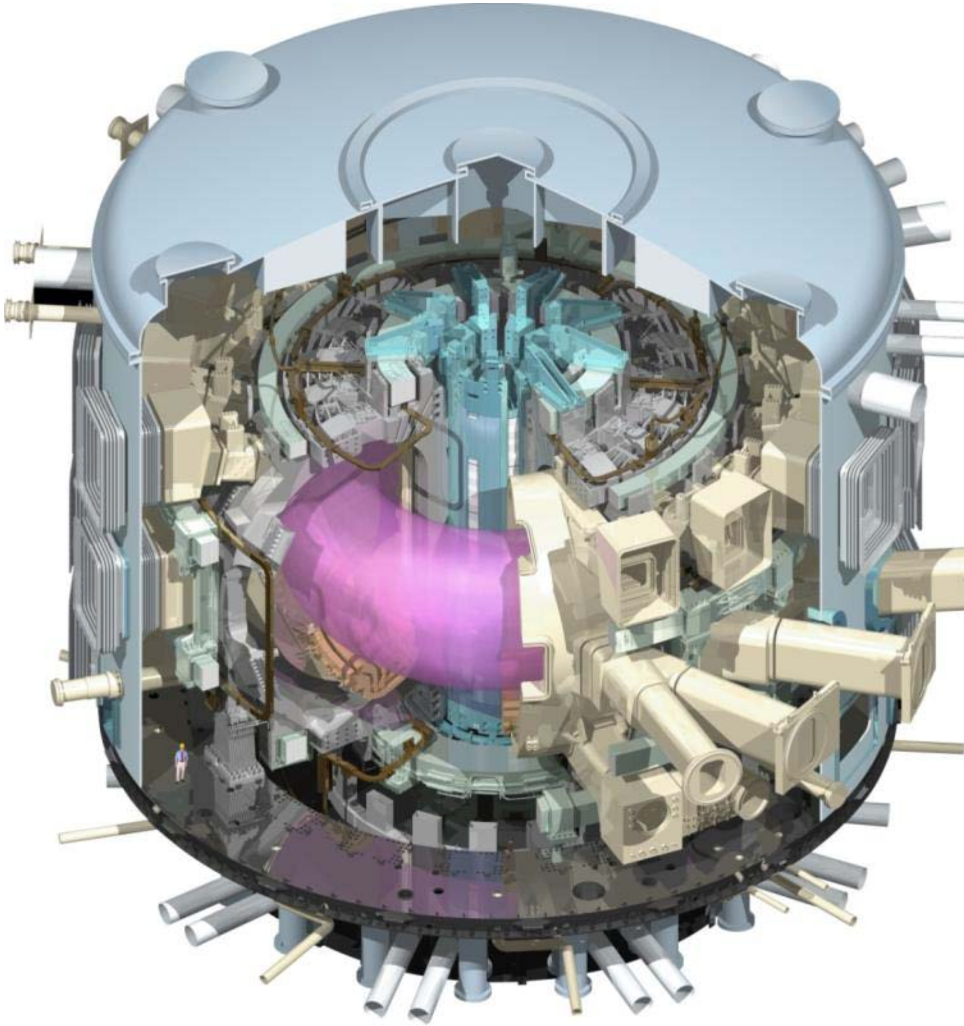
Many countries plan to expand their use of nuclear fission, USA expects a nuclear renaissance, and China, India and Russia have even more ambitious plans for expanding nuclear power by 2030



The next generation of nuclear energy systems, Generation IV, may be deployed from 2040

Nuclear fusion

Fusion research is taking the next step with the construction of ITER, followed by DEMO in 2030-2040. The first commercial fusion power plant might be commissioned by 2050



CCS

Carbon Capture and Storage (CCS) can be used on large point sources based on fossil fuels such as power plants and industrial furnaces

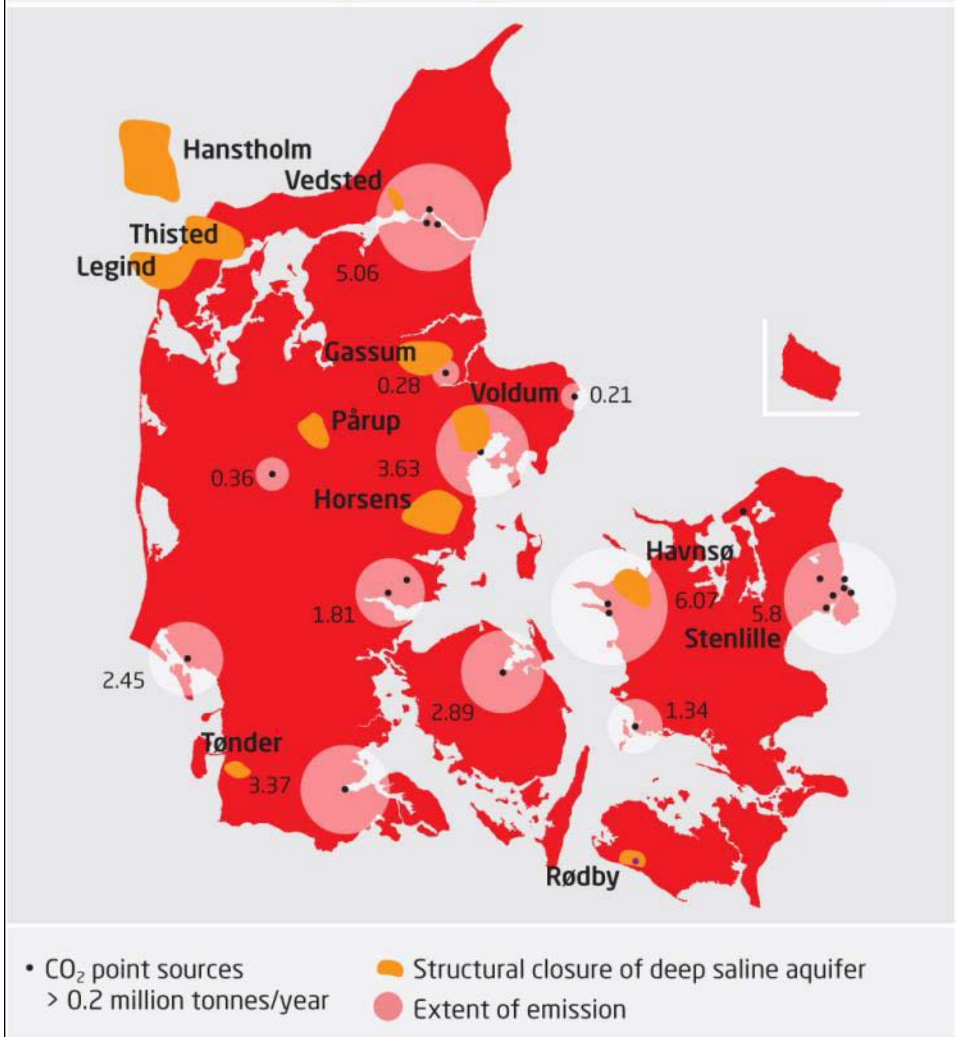
With CCS we can continue to burn fossil fuels even in a carbon-neutral future

CCS can even be used with biomass-fired power plants to create net negative CO_2 emissions.

Denmark has a good chance of exploiting CCS

Figure 40

The largest potential sites for Danish underground CO_2 storage (excluding hydrocarbon fields in the North Sea), and the largest emitters. Source: Geological Survey of Denmark and Greenland



System aspects

It will not be possible to develop the energy systems of the future simply by improving the components of existing systems.

An integrated approach is needed that will optimise the entire system, from energy production, through conversion to an energy carrier, energy transport and distribution, and efficient end-use.

Systems aspects

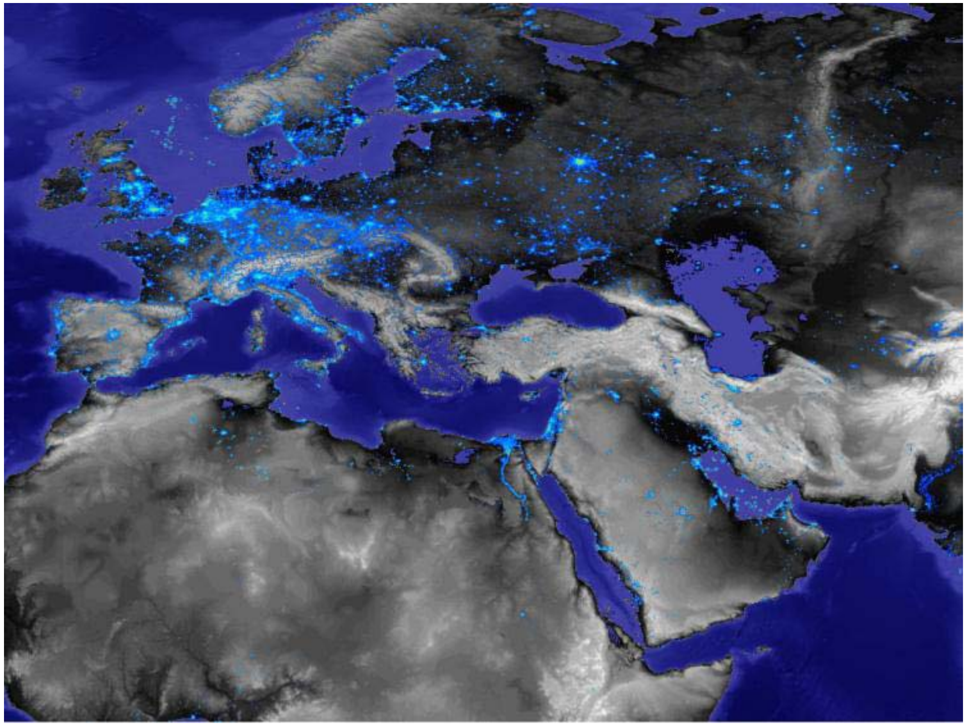
Automatic adaptation of consumption to match the availability of energy

A smart grid must link production and end-use at the local level

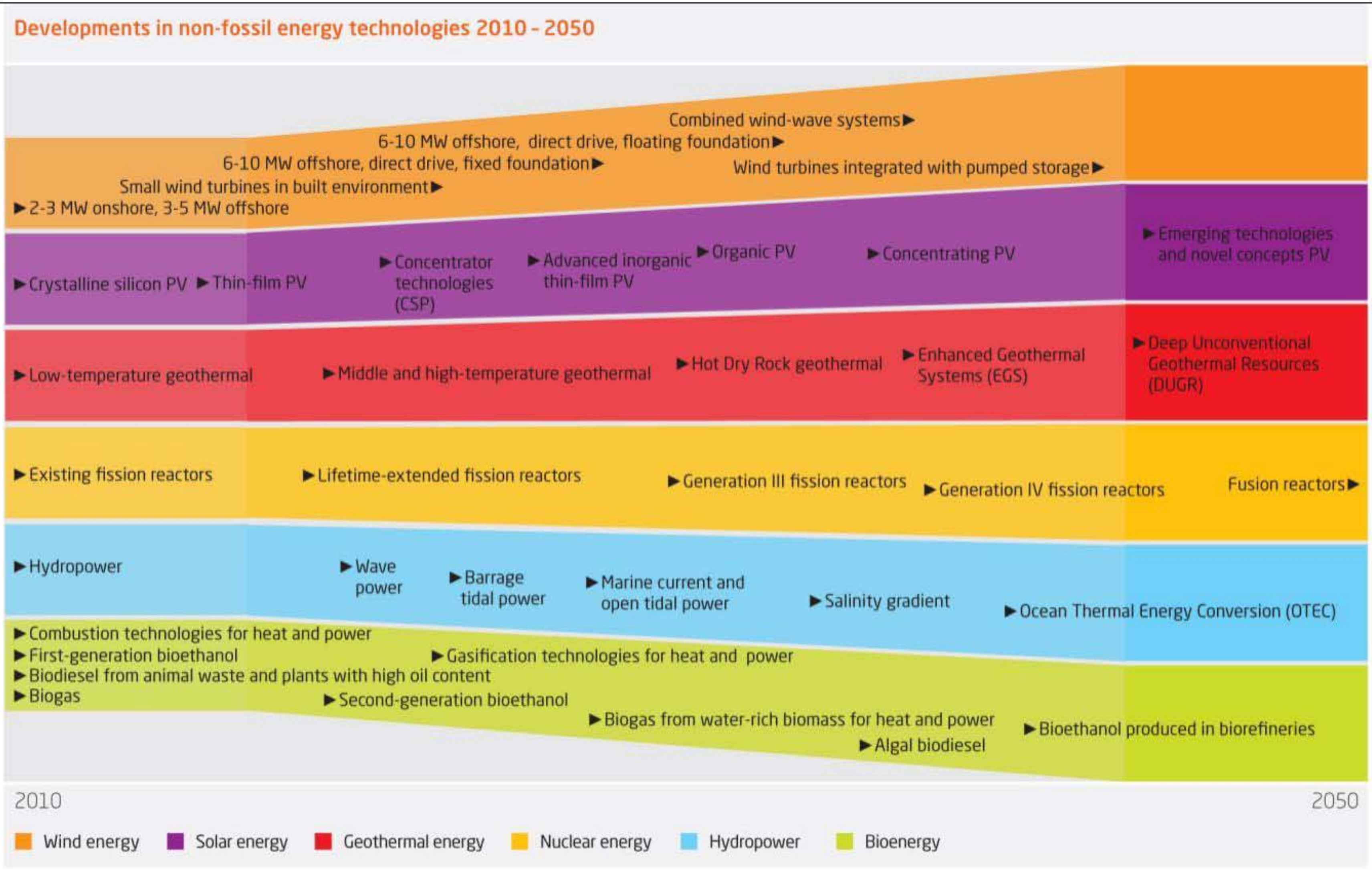
Electric supergrids is needed to handle wind power effectively

Taxes and tariffs should stimulate flexible demand

Information and communications technology (ICT) will be very important to the successful integration of renewables in the grid



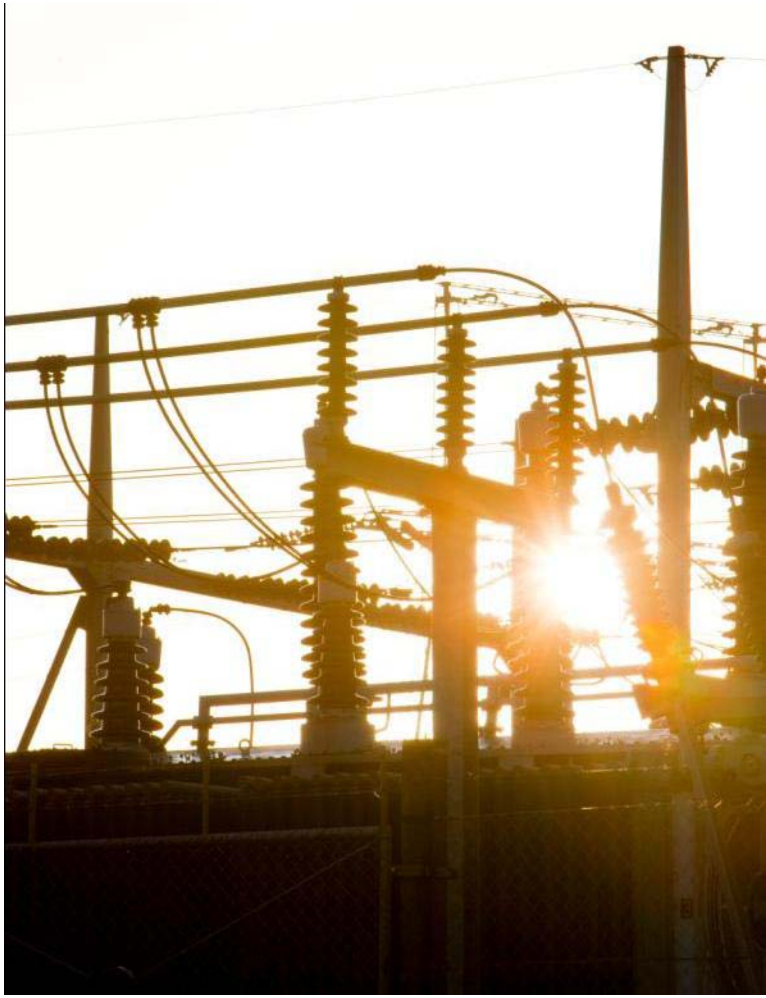
Main conclusions



Main conclusions

- By 2050, the sum of the potential of all the low-carbon energy sources exceeds the expected demand. The challenge for a sustainable global energy system with low CO_2 emissions by 2050 is therefore to utilise this potential in the energy system to the extent that it can be done in an economically attractive way.

- It will not be possible to develop the energy systems of the future simply by improving the components of existing systems. Instead, we need an integrated process that will optimise the entire system, from energy production, through conversion to an energy carrier, energy transport and distribution, and efficient end-use.



Main conclusions

- Similarly, significant reductions in primary energy consumption will not be reached through evolutionary development of existing systems. This will require paradigm shifts and revolutionary changes, such as the automatic adaptation of consumption to match the instantaneous availability of all forms of energy.
- Several energy supply technologies with low or even zero GHG emissions are already available on the market or will be commercialised in the decades ahead.

Main conclusions

- A future intelligent power system requires investment now, since uncertainty among investors is already hindering progress towards a higher share of renewable energy. If we do not make this investment, future generations may look back in disbelief that for so long we tolerated an antiquated energy system without putting in place the improvements that were already possible.